Chapter 10

Oxygen Equipment and Cabin Pressurization

With the technological advances of today's Army aircraft and the increase of operational requirements to conduct operations at altitudes exceeding 10,000 feet MSL, oxygen equipment and cabin pressurization are crucial. Without supplemental oxygen and cabin pressurization, crew members increase their risks of hypoxia, evolved-gas disorders, and decompression sickness. This chapter explains cabin pressurization and oxygen equipment and their use in Army aviation.

OXYGEN SYSTEMS

10-1. Aircraft oxygen systems consist of containers that store oxygen either in a gaseous, liquid, or solid state; tubing to direct the flow; devices that control the pressure and the percentage of oxygen; and a mask to deliver oxygen to the user. The oxygen systems can exist in many forms throughout the military, but the following equipment is used in Army aircraft.

GASEOUS OXYGEN

10-2. Aviator's gaseous oxygen is the most common breathing oxygen found in Army aircraft. It is classified as Type I, Grade A, and meets the military specifications in MIL-O-27210E. This form is 99.5 percent pure by volume and contains no more than 0.005 milligrams of water vapor per liter at 760 mm/Hg pressure and 15 degrees Celsius. Gaseous oxygen is odorless and free from contaminants.

10-3. The oxygen used for medical purposes is classified as Type I, Grade B, and is not acceptable for use by aviators because of its high moisture content. This is important because at high altitudes the temperature may cause freezing in the oxygen-delivery system and restrict the flow of oxygen.

ONBOARD OXYGEN-GENERATING SYSTEM

10-4. The OBOGS is the primary method of providing oxygen to patients aboard the UH-60Q Black Hawk. The use of this system reduces many of the potential hazards associated with gaseous high-pressure systems. In addition, the service and maintenance of this system is simpler than other systems. Various onboard oxygen-generating systems have been tested, and some show great potential for future military use. The aircraft technical manual contains the specific capabilities of the OBOGS.

STORAGE SYSTEMS

GASEOUS LOW-PRESSURE SYSTEM

10-5. In this type of system, the breathing oxygen is stored in yellow, lightweight, shatterproof cylinders that contain a maximum charge pressure of 400 to 450 pounds per square inch. This system is not very effective because the low pressure limits the volume of oxygen that can be stored. In addition, if this system falls below 50 pounds per square inch, it must be recharged within two hours to prevent moisture condensation within the cylinder. If not recharged, the system must be purged before it is refilled. Low-pressure oxygen is commonly used during an emergency.

GASEOUS HIGH-PRESSURE SYSTEM

10-6. This type of system is in use aboard most Army aircraft with internal storage systems. In this system, the breathing oxygen is stored in green heavyweight cylinders that contain a maximum charge pressure of 1,800 to 2,200 pounds per square inch. Large amounts of oxygen can be safely stored to meet the mission requirements of the Army's fixed-wing aircraft.

10-7. The H-2 bailout bottle is a gaseous high-pressure (1,800 to 2,000 pounds per square inch) system. It provides an emergency source of oxygen in case the aircraft oxygen system fails. It also provides high-altitude parachutists with a source of oxygen during a high-altitude jump. This system automatically activates during an ejection sequence or is manually activated by pulling the ball handle ("Green Apple"). Once this system is activated, it cannot be stopped. The bailout bottle provides about 10 minutes of breathing oxygen.

10-8. The helicopter oxygen system is a self-contained portable oxygen system that supplies oxygen to crew members on missions requiring oxygen at altitude. The HOS (Figure 10-1) is tailored for use in the UH-60, CH-47 (forward or aft), and the UH-1. It can also be used in other aircraft not listed, but additional supply hoses may be required. Each HOS can provide 100 percent oxygen to six personnel for one hour at altitudes up to 25,000 feet MSL. Oxygen is stored in two tandem-connected storage cylinders that have to be recharged by an oxygen servicing unit.

OXYGEN REGULATORS

10-9. The flow of oxygen into the mask must be controlled when oxygen systems are used onboard aircraft. Two types of oxygen regulators are used in Army aircraft: diluter demand and continuous flow.

QUICK-DONNING MASK-REGULATOR

10-10. A diluter-demand regulator wastes less oxygen than a continuous-flow regulator, fits better, and provides the user a high percentage of oxygen. A mask-regulator makes up the self-contained, quick-donning unit that is available for pilots who encounter pressurization problems within the cabin. Figure 10-2 shows this mask-regulator assembly unit.

Figure 10-1. Helicopter Oxygen System

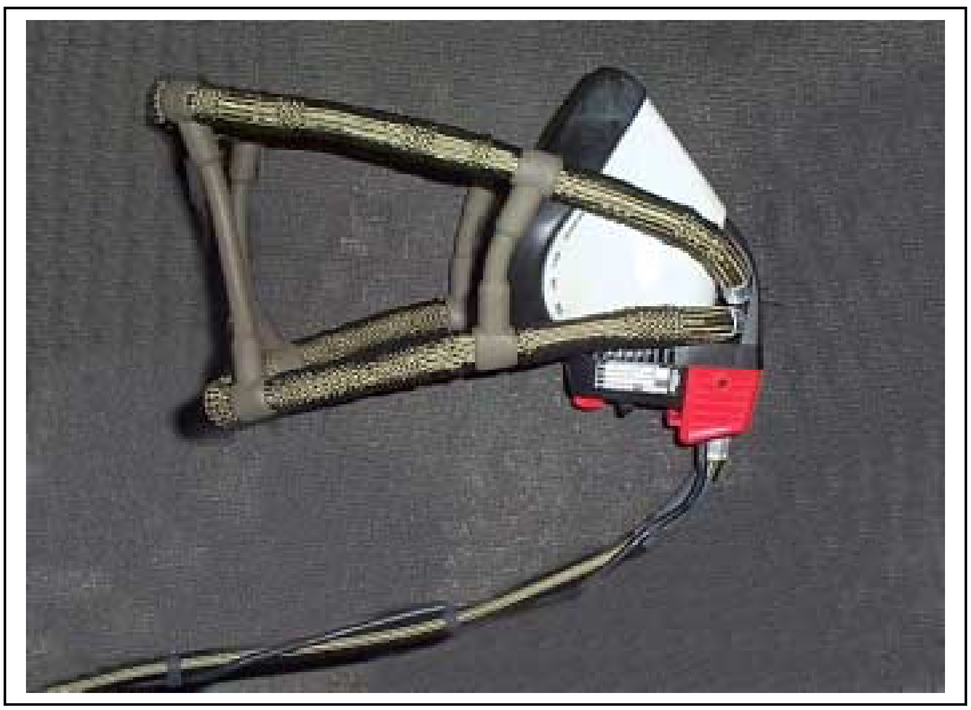

Figure 10-2. Quick-Donning Mask-Regulator

10-11. During each inhalation, negative pressure closes the one-way exhaust valve in the mask and opens the demand valve in the regulator. This provides an oxygen flow only on demand. This regulator can mix suitable amounts of ambient air and oxygen to prolong the oxygen source. When the diluter level is placed in the position marked “NORMAL,” the breathing mixture at ground level is mainly ambient air with very little added oxygen. During ascent, an air inlet is partially closed by an aneroid pressure valve to provide a higher concentration of oxygen. This inlet valve closes completely at 34,000 feet MSL, and the regulator then delivers 100 percent oxygen. On descent, this process reverses.

10-12. The regulator can also provide 100 percent oxygen when the diluter lever is placed in the position marked “100% OXYGEN” at any altitude. The diluter level is set on “NORMAL” for routine operations; it is placed on “100% OXYGEN” when hypoxia is suspected or prebreathing is required.

CONTINUOUS-FLOW OXYGEN REGULATOR

10-13. Continuous-flow oxygen systems provide protection for passengers up to 25,000 feet MSL and provide a continuous flow of 100 percent oxygen to the user. The three major types of regulators in this system are manual, automatic, and automatic with manual override.

OXYGEN MASKS

10-14. Three main oxygen masks used by the Army’s aviation community are the passenger, MBU-12/P, and diluter-demand quick-don mask. Except for the passenger mask, which is a continuous-flow mask, oxygen masks are pressure-demand masks. The continuous-flow mask supplies oxygen continuously to the user; the pressure-demand mask allows oxygen to enter the mask only when the user inhales. The oxygen in the mask is then maintained at a positive pressure until the regulator pressure is overcome during exhalation.

PASSENGER OXYGEN MASK

10-15. The passenger mask, found onboard Army fixed-wing aircraft, supplies a continuous flow of oxygen whether the users are inhaling or not. The mask (Figure 10-3) plugs into receptacles within the passenger compartment.

Figure 10-3. Passenger Oxygen Mask

MBU-12/P OXYGEN MASK

10-16. The MBU-12/P mask (Figure 10-4) comes in four sizes: short, regular, long, and extra long. To ensure a proper fit, individuals should wear a mask in the size that most nearly matches their facial measurements.

10-17. The MBU-12/P oxygen mask consists of a silicone rubber inner face piece, bonded to the hard shell to form a one-piece assembly. The MBU-12/P is an improvement over previous masks; it is more comfortable, fits better, and offers increased downward vision.

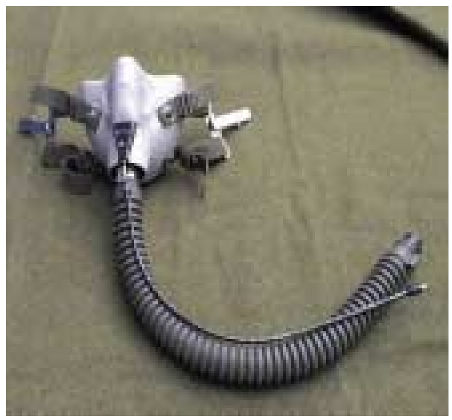

Figure 10-4. MBU-12/P Oxygen Mask

OXYGEN-EQUIPMENT CHECKLIST

10-18. Because oxygen equipment can easily malfunction, it must be checked continually. Aircrew members check their oxygen system equipment using the appropriate checklist or technical manual.

CABIN PRESSURIZATION

10-19. The Army's fixed-wing aircraft can fly at higher altitudes than crew members can physiologically tolerate. Therefore, cabin pressurization was developed for the safety and comfort of crew members and passengers.

SYSTEM OF CABIN PRESSURIZATION

10-20. The most efficient method for protecting crew members flying at altitude is to increase the barometric pressure inside the cabin area so that it is greater than the ambient pressure outside. In high-altitude flight without pressurization, crew members require continual use of oxygen equipment. Continual use increases crew fatigue. Pressurization, however, does have disadvantages. If crew members encounter problems with cabin pressurization, they may suffer serious physiological impairment.

10-21. Because greater pressure must exist inside the cabin than outside, the aircraft wall must be structurally reinforced to contain this pressure. This reinforcement increases the design and maintenance costs of the aircraft, and the added weight and increased power requirements reduce its performance.

10-22. Cabin pressurization is achieved by extracting outside ambient air, forcing it through compressors, cooling it, and maintaining it at a given cabin altitude. Pressurization is maintained by controlling the amount of air that is allowed to escape in relation to the air that is compressed. In the typical cabin pressurization system, the controls sense changes in both cabin and outside ambient air pressure and make the necessary adjustments to maintain the cabin pressure at a fixed pressure differential. (This differential is the difference between the cabin pressure and the outside ambient air pressure.) A cabin altimeter, usually part of the pressurization system, allows the pilot to observe the cabin altitude and make the required cabin pressure changes.

10-23. The cabin altitude on most aircraft usually increases with aircraft altitude until an altitude of 5,000 to 8,000 feet is reached. Barometric control then maintains the cabin at that set altitude until the maximum pressure differential for the aircraft is reached.

10-24. From sea level to 20,000 feet MSL, a barometric controller modulates the outflow of air from the cabin to maintain a selected cabin rate of climb. Cabin altitude increases until the maximum cabin pressure differential of 6.0 pounds per square inch is reached. Thus, below an altitude of 20,000 feet MSL, a cabin pressure altitude of 3,870 feet MSL can be maintained.

10-25. From 20,000 to 31,000 feet MSL (the service ceiling of the C-12D), the maximum pressure differential is maintained; however, the cabin altitude will increase (Figure 10-5). At 31,000 feet MSL and a pressure differential of 6.0 pounds per square inch, a cabin altitude of 9,840 feet MSL is reached.

10-26. The cabin pressurization selected for a particular aircraft is usually a compromise among physiological requirements, engineering capability, overall aircraft performance, and cost.

ADVANTAGES OF CABIN PRESSURIZATION

10-27. For aircraft capable of flight above 20,000 feet MSL, cabin pressurization has several advantages. In general, pressurization will—

- Eliminate the need for supplemental-oxygen equipment.
- Reduce significantly the occurrences of hypoxia and decompression sickness.
- Minimize trapped-gas expansion.
- Reduce crew fatigue because cabin temperature and ventilation can be controlled within desired ranges.

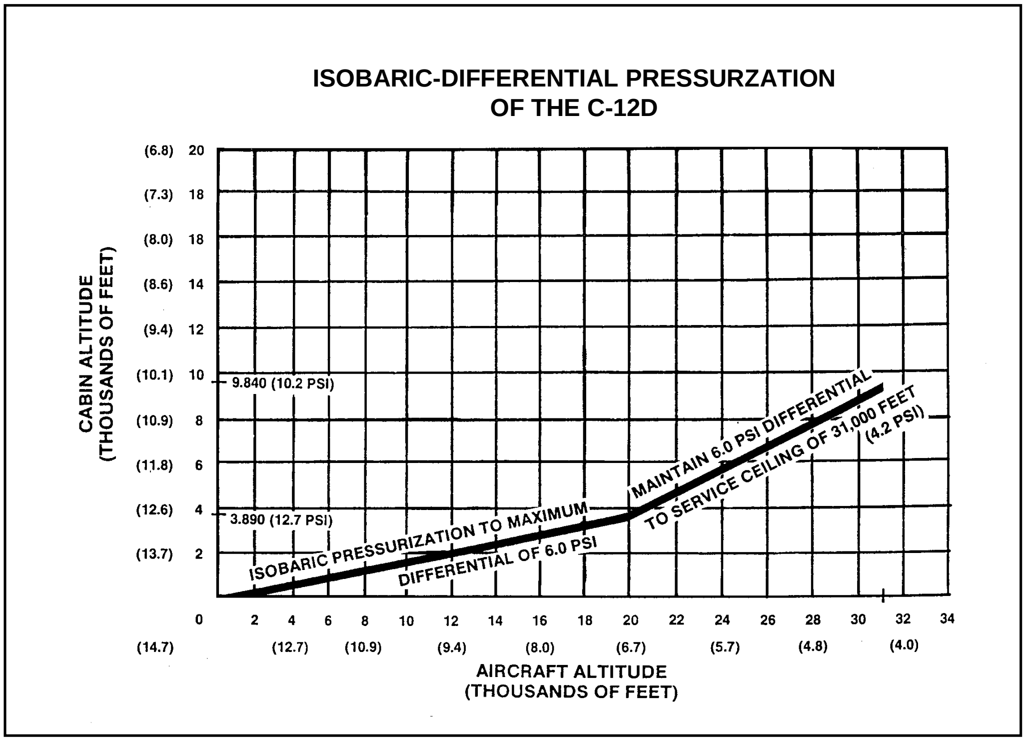

Figure 10-5. C-12D Cabin Pressurization Changes With Altitude Changes

LOSS OF CABIN PRESSURIZATION

10-28. Failure of the pressurization system and the resulting decompression can produce significant physiological problems for crew members. Slow decompression of the cabin, although dangerous because of the slow and insidious onset of hypoxia, is not as physiologically dangerous as rapid decompression. A rapid decompression occurs when the fuselage or pressure vessel is compromised and the cabin pressure equalizes almost instantaneously with outside ambient pressure.

10-29. The following factors control the rate and time of decompression:

- **Volume of the pressurized cabin.** The larger the cabin area, the slower the decompression time.
- **Size of the opening.** The larger the opening, the faster the decompression.
- **Pressure differential.** The larger the pressure differential between the outside absolute pressure and the interior cabin pressure, the more severe the decompression.
- **Pressure ratio.** The greater the difference between inside and outside pressures of the cabin, the longer the time for air to escape and the longer the decompression time.

10-30. The physiological effects of a rapid decompression range from trapped-gas expansion—within the ears, sinuses, lungs, and abdomen—to hypoxia. The gas-expansion disorders can be painful and may become severe, but they are transient. The most serious hazard for the aircrew member is hypoxia. The onset of hypoxia can be rapid, depending on the cabin altitude after the decompression. For the average individual, the EPT is decreased by half following a rapid decompression. Crew members may also experience decompression sickness, cold, and windchill.

INDICATIONS OF RAPID DECOMPRESSION

10-31. The rapidity of the decompression determines the magnitude of the observable characteristics of decompression. The earlier that crew members detect a loss of pressure, the quicker that they can take appropriate emergency measures to increase survival. All of the following observable characteristics may indicate loss of pressure.

Noise

10-32. Anytime two different air masses make contact, there is a loud, popping noise. This explosive sound is often called "explosive decompression."

Flying Debris

10-33. Crew members need to be alert to the possibility of flying debris during a rapid decompression. The rush of air from inside an aircraft structure to the outside is of such force that items not secured may be ejected from the aircraft.

Fogging

10-34. The sudden loss of pressure causes condensation and the resulting fog effect. Fogging is one of the primary characteristics of any decompression because air at a given temperature and pressure can hold only so much water vapor.

Temperature

10-35. With a loss of pressurization, cabin temperature equalizes with the outside ambient temperature, which significantly decreases cabin temperature. The amount of temperature decrease depends on altitude.

IMMEDIATE ACTIONS FOLLOWING DECOMPRESSION

10-36. After cabin decompression occurs, all crew members and passengers should breathe supplemental oxygen. Immediate descent should be made to an altitude that will minimize the physiological effects of the pressure loss.